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(54) Metal coated substrates with composite layer of dielectric material

(57) A coated substrate for use in a glazing panel or optical filter to impart solar screening properties thereto while avoiding an aesthetically unattractive purple colour in reflection is provided by the presence on the substrate of a stack of coating layers comprising (i) a layer of dielectric material, (ii) a layer of a metal selected from silver, gold, copper and alloys of one or more thereof, and (iii) a further layer of dielectric material, characterised in that the layer (i) of dielectric material is a composite layer which includes a sub-layer of a selectively absorbent material with a refractive index of at least 1.4, a spectral absorption index k_{λ} of at least 0.4 in the range $380 < \lambda < 450$ nm and presenting a ratio $k_{380 < \lambda < 450 \text{ nm}} / k_{650 < \lambda < 760 \text{ nm}} > 2$. The selectively absorbent material of the sub-layer may be stainless steel oxide (SSO_x) ferric oxide, chromium oxide, palladium oxide or zirconia. The composite dielectric layer may comprise a) TiO₂, Fe₂O₃ and TiO₂; b) SnO₂/ZnO, SSO_x and ZnO; c) SnO₂, SSO_x, SnO₂/ZnO; d) SnO₂/Fe₂O₃ and SnO₂/ZnO.

The coating stack may include a further metal layer and a further dielectric layer. A sacrificial barrier layer may be included immediately above the or each metallic layer. This may be titanium metal which is substantially completely oxidised in the finished coating. A coated substrate may contain two metal layers.

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Metal coated substrates

The present invention relates to metal-coated substrates, and in particular to a metal-coated transparent substrate sheet in which the metal is silver, gold or copper or an alloy of one or more thereof.

Such coated substrates find application as, for example, window glazing for buildings or vehicles, in laminated structures and as optical filters.

Panels used as window glazing in buildings desirably have a low solar factor (FS, defined below) so that the interior of the building is not overheated by solar radiation, while also having an adequate level of luminous transmittance (TL, defined below) so as to provide sufficient internal light. These somewhat conflicting requirements can also be expressed as a need for the panel to display good selectivity, i.e. a high ratio of luminous transmittance to solar factor (further defined below). It is also desirable that the glazing panels present both a neutral aspect in reflection, otherwise expressed as a low colour purity, and a low level of reflection but these are properties which tend to be difficult to achieve in combination with high selectivity.

It is known to improve the selectivity of a metallic coating on glazing by increasing the thickness of the metallic layer(s). However this has the disadvantage of imparting to the glazing a purple colour in reflection, which tends to be regarded as aesthetically unattractive. It has therefore been proposed to overcome the disadvantage by use of an oxide layer beneath the metal, the said oxide layer having a higher refractive index than other oxide layers in the coating, whereby interference effects are created between the respective oxide layers which reduce the undesired coloration. French patent specification 2719036 teaches the use as such an underlayer of an oxide selected from niobium oxide and tantalum oxide. Such a high refractive index underlayer does not however favour the achievement of a low luminous reflectance (RL), and consequently of a high selectivity, of the coated substrate. Our earlier GB patent specifications 2229737 and 2229738 describe a substrate of a glazing material carrying a multi-layer coating which comprises a reflective layer of silver sandwiched between a transparent undercoat and a transparent overcoat. The undercoat comprises at least one layer of a metal oxide over which is deposited a layer of zinc oxide up to 15 nm thick. The overcoat comprises a layer of an oxide of a sacrificial metal such as aluminium, bismuth, stainless steel, tin or titanium or of a mixture thereof.

The present invention has the objective of providing an improved coating

stack in which both the purple colour in reflection is neutralised and a low level of reflection is achieved, without resulting disadvantages in the stack's selectivity.

Several of the properties of a coated substrate have precise meanings defined by an appropriate standard. Those used herein include the following, based on
 5 the definitions of the International Commission on Illumination - Commission Internationale de l'Eclairage ("CIE").

The standard illuminant quoted herein is Illuminant C, as defined by CIE. Illuminant C represents average daylight having a colour temperature of 6700°K.

The "luminous transmittance" (TL) is the luminous flux transmitted through
 10 a substrate as a percentage of the incident luminous flux (*of Illuminant C*). ~~transmitted~~

The "luminous reflectance" (RL) is the luminous flux reflected from a substrate as a percentage of the incident luminous flux of Illuminant C.

The "spectral absorption index" (k_λ) of a substrate is defined by the formula:

$$15 \quad (k_\lambda) = \frac{\lambda}{4\pi} a(\lambda)$$

where $a(\lambda)$ is the spectral linear absorption coefficient.

The "solar factor" (FS) is the ratio of the sum of the total energy directly
 20 transmitted through a substrate and the energy which is absorbed and re-radiated on the side away from the energy source as a proportion of the total radiant energy incident on the substrate.

The "selectivity" (SE) of the coated substrate is the ratio of the luminous transmittance (TL) to the solar factor (FS).

25 The "purity" (p) of the colour of the substrate refers to the excitation purity measured with Illuminant C as defined in the CIE International Lighting Vocabulary, 1987, pages 87 and 89. The purity is specified according to a linear scale on which a defined white light source has a purity of zero and the pure colour has a purity of 100%. The purity of the coated substrate is measured from the side opposite the side with the
 30 coating.

The term "refractive index" (n) is defined in the CIE International Lighting Vocabulary, 1987, page 138.

The "dominant wavelength" (λ_D), also known as the "tint", is the peak wavelength in the range transmitted or reflected by the coated substrate.

35 According to the present invention there is provided a coated substrate carrying a stack of coating layers comprising, in sequence from the substrate, (i) a layer of dielectric material, (ii) a layer of a metal selected from silver, gold, copper and alloys of one or more thereof, and (iii) a further layer of dielectric material, characterised in that the layer (i) of dielectric material is a composite layer which includes a sub-layer of a

selectively absorbent material with a refractive index of at least 1.4, a spectral absorption index

k_λ of at least 0.4 in the range $380 < \lambda < 450$ nm and presenting a ratio $k_{380 < \lambda < 450 \text{ nm}} / k_{650 < \lambda < 760 \text{ nm}} > 2$.

5 The coated substrates of the invention are thus characterised by a sub-layer formed of material(s) with particular absorbent properties which differ from those of the sub-layer of our earlier applications. Absorption of the blue component of the undesirable purple colour due to the thickness of the metallic layer(s), which by reference to the ratio k (for $380 < \lambda < 450$ nm)/ k (for $650 < \lambda < 760$ nm) should be > 2 , is satisfied by the material(s) which form the sub-layer. The quoted wavelength ranges are within the visible spectrum.

10 The invention thus employs two colour-neutralising mechanisms: absorption in the blue part of the spectrum (wavelengths in the range of about 450 nm and below) and interference effects displayed by the collective layers of the stack in the red part of the spectrum (wavelengths in the range of about 650 nm and above); and are thus more effective than previous proposals in reducing the purple coloration. Moreover, contrary to previous proposals which relied simply on interference effects, the invention does not require the use of a neutralising layer with a refractive index higher than that of other oxide or nitride layers. The coating stack also displays an improved, i.e. reduced, 15 purity of reflection, and remarkably this is achieved in combination with a very low level of luminous reflectance (RL).

20 The coated substrates of the invention, and thus glazing panels including them, have the high selectivity associated with the presence of large thicknesses of metallic layers but without the significant reflection and strong purple coloration generally inherent in such products. In comparison with a similarly coated substrate containing one or more thick metallic layers but without the absorbent material, the panels according to the invention offer a selectivity at least as good, a higher dominant wavelength in reflection (λ_D) - tending towards green - but simultaneously with a weaker reflection from the glass side (RL) and a lower colour purity in reflection (p).

30 In further embodiments of the invention the coating stack may include a further metal layer (iv) and a further dielectric layer (v).

A sacrificial barrier layer, for example of a metal selected from chromium, chromium/nickel alloy, niobium, tantalum, tin, titanium and zinc, is desirably provided immediately above the or each metallic layer. The preferred sacrificial metal is titanium. 35 The sacrificial metal takes up oxygen that would otherwise attack the metallic layer during and after the formation of the coating and the resultant oxide provides a protective layer on the metallic layer. From the viewpoint of the sacrificial duty the sacrificial metal preferably has a thickness of 2 to 5 nm, but the use of a thickness of up to 10 nm may be beneficial in leaving an unoxidised layer of the sacrificial metal to enhance the anti-solar

properties of the coating as a whole.

The dielectric materials of layers (i), (iii) and (v) preferably comprise at least one metal oxide or metal nitride. Suitable examples of these include alumina (Al_2O_3), aluminium oxynitride, magnesia (MgO), niobium oxide, (Nb_2O_5), silica (SiO_2), silicon nitride (Si_3N_4), tantalum oxide (TaO_2), tin oxide (SnO_2), titanium dioxide (TiO_2), yttrium oxide (Y_2O_3), zinc oxide (ZnO), and zinc sulphide (ZnS). These may be used alone or in combination. They are non-absorbent transparent materials capable of adjusting the luminous reflectance RL and the colour purity p . The required optical interference effects whereby the stack reduces the purple reflection are conveniently achieved by multiple sub-layers of the said materials, for example SnO_2/ZnO or $\text{ZnO}/\text{SnO}_2/\text{ZnO}$.

In a stack having a single metal layer the thicknesses of the dielectric layers (i) and (iii) are preferably in the ranges 15-45 nm and 30-60 nm respectively, most preferably 25-45 nm and 35-55 nm. In a stack having two metal layers the thicknesses of the dielectric layers (i), (iii) and (v) are preferably in the ranges 15-35 nm, 60-90 nm and 20-40 nm respectively.

The selectivity of a coated substrate including the sub-layer has been found to be at least as high as an equivalent coated substrate from which the sub-layer product is absent.

Suitable examples of the selectively absorbent material for the said sub-layer are stainless steel oxide (SSOx), ferric oxide (Fe_2O_3), a chromium oxide (CrO_x : CrO or Cr_2O_3), palladium oxide (PdO), germanium, a germanium oxide (GeO_x , where $0 < x < 1$), silicon and a silicon oxide (SiO_x , where $0 < x < 1$), of which stainless steel oxide and ferric oxide are preferred. Ferric oxide has an advantage over stainless steel oxide in terms of colour neutralisation but this is to some extent reversed because stainless steel oxide is not magnetic and thus is easier to deposit than ferric oxide, whose diamagnetism hinders its application by magnetron cathode sputtering.

It is to be noted that these selectively absorbent materials also have good absorbent properties for ultra violet (UV) wavelengths. Thus a glazing panel with a coating stack including such a selectively absorbent material offers the further advantage of reducing the amount of UV-radiation entering a room and thereby protects from discoloration any textiles and plastics in the room.

Although the layers (iii) or (v) can similarly include a sub-layer of a selectively absorbent material the required degree of absorbency is in many cases adequately obtained by the sub-layer in the first layer (i) alone.

The thickness of the or each selectively absorbent sub-layer should preferably be less than 15 nm. Coated substrates according to the invention in which the thickness of the said sub-layer is less than 5 nm are of especial interest. A 5 nm thickness of SSOx permits the colour neutralisation of a 14 nm silver layer and the same thickness of Fe_2O_3 permits the neutralisation of a 17.5 nm silver layer.

The metal layers (ii) and (iv) are formed of silver, gold or copper or an alloy of one or more thereof. In one embodiment of the invention with a single metal layer (ii) present in the stack the metal thickness is preferably in the range 10 to 20 nm, being associated with a luminous reflectance (RL) of less than 20%. In another
 5 embodiment of the invention with a single metal layer (ii) present in the stack its thickness is preferably in the range of more than 20 nm up to 30 nm, being associated with a luminous reflectance (RL) of less than 40%.

When two such layers (ii) and (iv) are present their thicknesses are preferably each in the range 10 to 25 nm.

10 The use of an absorbent sub-layer in the first dielectric layer (i) favours the achievement of a lower luminous reflectance (RL) value for the coated substrate than for a traditional "neutralising" stack having metal layers of the same thickness(es) as those of the said coated substrate. In the case of a coating stack according to the invention with two metal layers (ii) and (iv) the RL value is preferably less than 15%.

15 The substrate is most typically glass but can be another transparent material such as polycarbonate, polymethyl methacrylate or polyethylene terephthalate.

The coated substrate preferably has a colour purity (p) of less than 20%, more preferably less than 10%. This advantageously low colour purity is remarkable in being associated with the low RL values also achievable by the present invention.

20 Moreover, in addition to such a considerable reduction in the purity of the coated substrate, the invention also increases its dominant wavelength (λ_D), preferably to a dominant wavelength between 480 and 500 nm. In this wavelength range the tint is no longer purple but rather tending to blue to blue/green.

25 The thickness dimensions quoted herein for the layers and sub-layers of the coating stack are geometric thicknesses. The quoted properties of the coated substrate are measured on the basis of a single sheet of ordinary clear soda-lime glass having a thickness, unless otherwise specified, of 6 mm. The properties are as observed from the face opposite to the coated face, i.e. from the glass side. The opposite face is usually uncoated.

30 As used in a glazing panel the coated substrate is conveniently included with one or more uncoated substrate sheets in a multiple glazing assembly, with the coating being located on an internal face.

According to the invention it has become possible readily to achieve double glazing with levels of selectivity which hitherto were achieved with great difficulty.
 35 The invention provides for a selectivity of greater than 1.4 when employing a single metal layer in a coating stack and greater than 2.0 when employing a double metal layer in a coating stack. Moreover these high levels of selectivity are obtained in combination with low colour purity and low reflectivity.

While primarily described herein with reference to coated substrates used in

glazing panels the invention is also applicable to coated substrates employed in optical filters. Typical examples of such filters are monochromatic filters which serve to reduce the bandwidth of visible radiation passing through them. Also known as "quarter wavelength" or Fabry-Perot filters they are typically centred on the wavelength range of maximum human visual acuity ($550 \text{ nm} \pm 50 \text{ nm}$). In particular they can serve to eliminate those parts of the spectrum which do not contribute to luminous transmittance but are prejudicial to the solar factor, i.e. the infra-red and ultra-violet parts of the spectrum. They accordingly offer the possibility of obtaining higher selectivity values but this advantage is usually paid for by an undesired increase in colour purity in reflection.

The introduction of an absorbent sub-layer according to the invention allows this disadvantage to be overcome. The coated substrates for these filters are of the same structure as the double-metallic-layer coated substrates described above but have different thicknesses of dielectrics, namely:

- (i) and (v): less than 10 nm (excluding the selective absorbent sub-layer, which should be less than 15 nm)
- (iii): $(550 \text{ nm}/4n) \pm 15\%$
[where n represents the refractive index of the dielectric layer (iii)].

The coating layers are preferably applied by vacuum deposition. This method is preferred because it provides for coatings of readily controlled thickness and composition and thus assists in achieving the uniformity of product required by the invention. The deposition typically employs one or more vacuum deposition chambers, conveyors for the substrate, power sources and gas entry locks. Each deposition chamber contains planar magnetron sputtering cathodes, gas inlets and an evacuation outlet, deposition being achieved by passing the substrate several times under the cathodes. The pressure in the chambers is typically about 0.3 Pa.

The relatively low thicknesses of the respective layers of the coated substrate of the present invention provide operational advantages both in terms of the short time taken to apply the layers and in the economical use of the respective materials.

EXAMPLES

The invention is described in more detail with reference to the following non-limiting examples. For every example according to the invention there is at least one comparative example so as to demonstrate the improvements achieved by coated substrates according to the invention.

For each of the examples a substrate sheet of 6 mm clear glass was passed through a vacuum deposition apparatus including chambers having cathodes provided with targets formed, according to the particular stack, of titanium, stainless steel, iron, zinc and tin employed for respectively the deposition in an oxygen atmosphere of dielectric

sub-layers of titanium dioxide (TiO_2), stainless steel oxide (SSOx), ferric oxide (Fe_2O_3), zinc oxide (ZnO) and stannic oxide (SnO_2) [(i), (iii) and, in some instances (v)]. Targets of silver and titanium were similarly used for the deposition in an argon atmosphere of one or more layers of silver [(ii) and in some instances (iv)] and titanium as one or more
 5 sacrificial barrier layers.

The substrate sheet was subjected to return passages through the deposition apparatus so as to obtain the required layers and thicknesses of two or three layers of dielectric materials. The completed coating stacks included layers as shown in the accompanying Table 1. Their optical properties were examined from the glass side
 10 and the results are shown in Table 2. The TL, FS and SE results in the last three columns were obtained for a double glazing assembly incorporating a sheet coated as above. The intermediate space between the sheets of the assembly was filled with argon.

When in these examples the dielectrics contained sub-layers of the structure SnO_2/ZnO , these oxides were present in the same proportions (0.5/0.5). When the
 15 structures were of the type $\text{ZnO}/\text{SnO}_2/\text{ZnO}$, the proportions were 0.25/0.5/0.25.

In all the examples the absorption coefficient in the blue range ($380 < \lambda < 450$ nm) was between 0.4 and 1.2 for the SSOx and between 0.5 and 0.9 for the Fe_2O_3 .

Example 1 (comparative) illustrates the use of a high refractive index material (TiO_2 , which has a refractive index of 2.5 compared with about 2.0 for ZnO or SnO_2) in the dielectric 1. Such a material limits the colour purity of the purple colour caused by the important layer of silver used with reference to the use of a lower refractive index material. This corresponds to the prior art techniques. Example 2 (comparative)
 20 shows that even in the case of such a technique, the reflection is reduced, the colour purity is further reduced and the length of the dominant wavelength increased by the introduction of the first dielectric of an absorbent sub-layer according to the invention.

Example 3 illustrates that the thicker is the absorbent sub-layer, the lower is the stack's luminous reflectance and colour purity in reflection, and the higher is its dominant wavelength.

Example 10 illustrates an application of the invention in the field of optical filters. This example is also an illustration of the superior neutralising power of Fe_2O_3 compared with SSOx.
 30

Table 1 (thicknesses in nm)

Example	Dielectric 1 (i)			Metal (ii)	Barrier 1	Dielectric 2 (iii)	Metal (iv)	Barrier 2	Dielectric 3 (v)
	TiO ₂	Fe ₂ O ₃	TiO ₂	Ag	Ti	TiO ₂	Ag	Ti	ZnO/ SnO ₂ / ZnO
1	21	–	–	20	3	38.5	–	–	–
2	16	8	5	20	3	37	–	–	–
	SnO ₂ / ZnO	SSO _x	ZnO	“	“	ZnO/ SnO ₂ / ZnO	“	“	“
3a	34	–	–	13.5	3	42	–	–	–
3b	18	10	5	13.5	3	42	–	–	–
3c	13	13	5	13.5	3	42	–	–	–
4a	26	–	–	18	3	47	–	–	–
4b	15	6	5	18	3	47	–	–	–
5a	30	–	–	22.5	3	52	–	–	–
5b	20	4	6	22.5	3	52	–	–	–
6a	40	–	–	27	3	54	–	–	–
6b	30	4	6	27	3	54	–	–	–
	SnO ₂	“	SnO ₂ / ZnO	“	“	“	“	“	“
7a	–	–	28	14.5	3	73	14.5	3	28
7b	–	3	25	14.5	3	73	14.5	3	28
8a	–	–	32	16	3	80	16	3	32
8b	–	7	25	16	3	80	16	3	32
9/1a	–	–	31	18	3	81	18	3	31
9/1b	–	8	23	18	3	81	18	3	31
9/2a	–	–	22	11	3	80	21.5	3	33
9/2b	–	9	13	11	3	80	21.5	3	33
9/3a	–	–	22	14.5	3	80	18	3	33
9/3b	–	14	8	14.5	3	80	18	3	33
10a	–	–	5	11.5	3	61	10.5	3	5
	“	Fe ₂ O ₃	“	“	“	“	“	“	“
10b	5	15	–	11.5	3	61	10.5	3	5

Table 2

Example	TL (%)	RL (%)	λ_D (nm)	p (%)	TL (%)	FS (%)	SE
1	71.1	21.7	478	21.0	64	41	1.56
2	75.1	11.6	480	10.0	68	41	1.56
3a	84.5	8.2	472	23.0	76	52	1.46
3b	80.9	6.7	480	13.5	73	49	1.49
3c	78.9	5.8	487	7.9	71	48	1.48
4a	72.0	20.4	475	13.5	65	41	1.59
4b	71.7	17.1	481	5.3	65	40	1.63
5a	58.4	33.7	478	9.0	52	31	1.68
5b	58.7	30.3	490	2.2	53	31	1.71
6a	47.7	43.7	478	8.9	43	24	1.79
6b	47.9	39.6	486	2.5	43	24	1.79
7a	71.5	9.2	486	10.9	64	30	2.13
7b	70.2	8.0	494	4.7	63	29	2.17
8a	70.6	10.9	478	23.0	64	28	2.29
8b	67.6	7.7	483	7.7	61	25	2.44
9/1a	67.5	13.3	477	32.0	61	23	2.65
9/1b	64.7	8.9	481	14.8	58	21	2.76
9/2a	67.1	13.0	477	37.6	60	24	2.50
9/2b	64.0	13.0	485	16.3	58	23	2.52
9/3a	70.8	10.3	477	38.8	64	26	2.46
9/3b	66.7	7.1	481	18.8	62	25	2.48
10a	73.7	10.4	473	51.8	66	35	1.89
10b	67.0	11.1	489	18.2	61	33	1.85

CLAIMS

1. A coated substrate carrying a stack of coating layers comprising, in sequence from the substrate, (i) a layer of dielectric material, (ii) a layer of a metal selected from silver, gold, copper and alloys of one or more thereof, and (iii) a further layer of dielectric material, characterised in that the
5 layer (i) of dielectric material is a composite layer which includes a sub-layer of a selectively absorbent material with a refractive index of at least 1.4, a spectral absorption index k_{λ} of at least 0.4 in the range $380 < \lambda < 450$ nm and presenting a ratio $k_{380 < \lambda < 450 \text{ nm}} / k_{650 < \lambda < 760 \text{ nm}} > 2$.
2. A coated substrate as claimed in claim 1, in which the
10 coating stack includes a further metal layer (iv) and a further dielectric layer (v).
3. A coated substrate as claimed in claim 1 or claim 2, in which the coating includes a sacrificial barrier layer immediately above the or each metallic layer.
4. A coated substrate as claimed in claim 3, in which the
15 sacrificial barrier layer has a thickness of 2 to 5 nm.
5. A coated substrate as claimed in claim 3 or claim 4, in which the sacrificial barrier layer is titanium metal which is substantially completely oxidised in the finished coating.
6. A coated substrate as claimed in any preceding claim, in
20 which the material of the dielectric layers comprises at least one metal oxide or metal nitride.
7. A coated substrate as claimed in claim 6, in which the material of the dielectric layers comprises one or more of alumina, aluminium oxynitride, magnesia, niobium oxide, silica, silicon nitride, tantalum oxide, tin
25 oxide, titanium dioxide, yttrium oxide, zinc oxide and zinc sulphide.
8. A coated substrate as claimed in any preceding claim, in which the selectively absorbent material of the sub-layer is selected from stainless steel oxide, ferric oxide, a chromium oxide, palladium oxide and zirconia.
9. A coated substrate as claimed in any preceding claim, in
30 which the thickness of the selectively absorbent sub-layer is less than 15 nm.
10. A coated substrate as claimed in claim 9, in which the thickness of the selectively absorbent sub-layer is less than 5 nm.
11. A coated substrate as claimed in any preceding claim and
35 having a single metal layer, in which the thicknesses of the dielectric layers (i) and (iii) are in the ranges 25-45 nm and 35-55 nm respectively.

12. A coated substrate as claimed in any preceding claim and having a single metal layer, in which the thickness of the metal layer is in the range 10 to 20 nm.

13. A coated substrate as claimed in claim 12, which has a
5 luminous reflectance (RL) value of less than 20%.

14. A coated substrate as claimed in any one of claims 1 to 11 and having a single metal layer, in which the thickness of the metal layer is in the range of more than 20 nm up to 30 nm.

15. A coated substrate as claimed in claim 14, which has a
10 luminous reflectance (RL) value of less than 40%.

16. A coated substrate as claimed in any one of claims 1 to 10 and having two metal layers, in which the thicknesses of the said two layers are each in the range 10 to 25 nm.

17. A coated substrate as claimed in any one of claims 1 to
15 10, or 16 and having two metal layers, in which the thicknesses of the dielectric layers (i), (iii) and (v) are in the ranges 15-35 nm, 60-90 nm and 20-40 nm respectively.

18. A coated substrate as claimed in any preceding claim, which forms part of an optical filter.

19. A coated substrate as claimed in claim 18, in which the
20 thicknesses of the dielectric layers (i) and (v) are each less than 10 nm (excluding any selective absorbent sub-layer) and the thickness of the dielectric layers (iii) is $(550 \text{ nm}/4n) \pm 15\%$ [where n represents the refractive index of the dielectric layer (iii)].

20. A coated substrate as claimed in any one of claims 16 to
25 19, which has a luminous reflectance (RL) value of less than 15%.

21. A coated substrate as claimed in any preceding claim, which has a colour purity (p) of less than 20%, preferably less than 10%.

22. A coated substrate as claimed in any preceding claim,
30 which has a dominant wavelength in the range 480 to 500 nm.

23. A coated substrate as claimed in any preceding claim, which forms part of a glazing panel.

24. A double glazing panel including a coated substrate as claimed in any preceding claim.

25. A double glazing panel as claimed in claim 24 and having
35 a selectivity of greater than 1.4.



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Claims searched: 1-25

Examiner: Peter Beddoe
Date of search: 11 September 1997

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:
UK Cl (Ed.O): C7F (FHB, FHD, FHE, FHX, FPCL, FPCX, FPD, FPD, FPD)
Int Cl (Ed.6): C03C 17/36, C23C (14/08, 14/10, 14/18, 14/20)
Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
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X	EP 0678484 A2 (SAINT-GOBAIN) see eg ex 9	1 at least
X	EP 0593883 A1 (GLAS) see esp col 4 lines 39-50	1 at least
X	EP 0488048 A1 (ASAHI) see esp p7 lines 7-12	1 at least
X	EP 0464789 A1 (ASAHI) see esp exs 3,4	1 at least
X,P	US 5563734 (BOC) 8 October 1996 see esp Table 1	1 at least
X	US 5216551 (ASAHI) see esp col 10 lines 3-17 & fig 13	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.



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13

Application No: GB 9714525.4
Claims searched: 1-25

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Date of search: 11 September 1997

Category	Identity of document and relevant passage	Relevant to claims
X	US 5208095 (FORD) see esp col 4 lines 50-66	1 at least
X	US 5085926 (CENTRAL) see esp exs & claim 1	1 at least
X	US 4902580 (PPG) see esp example & claim 1	1 at least
X	US 4532181 (BOSCH) see esp col 2 lines 26-54	1 at least

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